Culture, Institutions & the *Long Divergence*

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The Long Divergence

Baghdad, c.800 C.E.

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The Early Middle Ages in Europe ...

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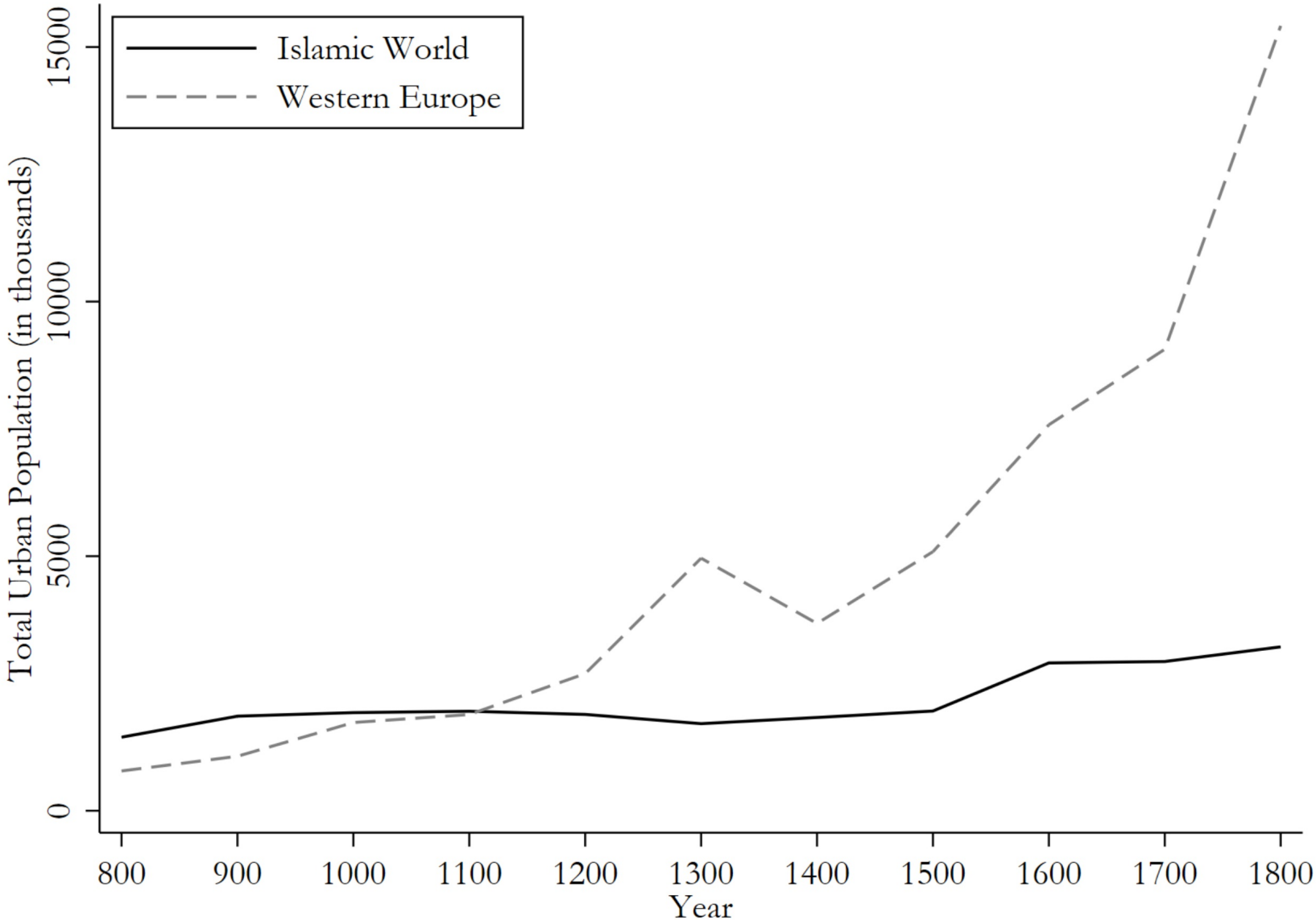
Timur Kuran calls this reversal of fortunes the "Long Divergence"

The Long Divergence

Urban Population



Stylized Facts Regarding the Long Divergence

Economic Divergence

1. Middle Eastern economies and fiscal capacity were far ahead Western Europe for centuries following the spread of Islam but ultimately fell far behind
2. Religious proscriptions (e.g., persistent use of Islamic law; Kuran 2011) dampened economic activity in both regions, but were more salient in MENA in the late medieval and early modern periods

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Political Divergence

3. Western Europe underwent political decentralization (via parliaments, feudal system) but the Middle East did not
4. Middle Eastern rulers continued to employ religious legitimacy; its importance waned in Western Europe in the late medieval period

Explanations for the Long Divergence

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3. Political centralization: Muslim rulers had access to slave soldiers, European rulers were weaker, had to cede more power to other elites (ultimately parliaments) (Blaydes and Chaney 2013)

What We Do

These frameworks each shed significant light on aspects of the Long Divergence, but none account for all of the stylized facts

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This paper offers a model that unifies these explanations in one framework

- Addressing the missing links in the prevailing explanations while offering further insights into long-run economic and political change
- Identifying the role of religious identity as a common (missing) thread in these explanations

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A model highlighting these tradeoffs allow us to study the interactions between institutions (legitimating elites, political centralization) and culture (religious identity)

Preview of the Model's Primary Insights

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1. The joint evolution of culture and political institutions is characterized by dynamics which converge to one of two distinct stationary states: a religious and a secular regime

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2. Societies in a religious state are less likely to decentralize politically

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4. Approaching the steady state, religious societies are less economically vibrant in the long-run due to the effects of religious proscriptions
5. Approaching the steady state, religious societies have lower fiscal capacity because they are politically centralized

The Logic of the Model

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2. Institutions encode the relative political power of different groups
3. Ruler can delegate power to clerics, who in turn provide legitimacy via services provided to the religious part of society
   - Religious legitimacy lowers the subjective tax rate for the religious
   - Comes at the cost of the imposition of religious proscriptions which affect all of society (e.g., usury ban)

You gotta see the model (cit.)

The Logic of the Model

4. The extent to which religious legitimacy is effective is related to the religious composition of society
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   - The cultural profile of values and preferences in society evolves according to socio-economic incentives
5. Institutional change is a mechanism to reallocate decision rights to internalize inefficiencies at equilibrium, reflected in the changing composition of cultural and political groups
   - Institutional change affects incentives for diffusion of cultural values $\Longrightarrow$ augments the fraction of individuals with such values in the population $\Longrightarrow$ incentives for the ruler to employ religious legitimacy

(Necessary) Snippets of the Model

Religious Legitimacy

Religious services facilitate governance and obedience for religious individuals. There are many ways to capture this in a model

Religious individuals subjectively perceive a tax rate τ_{Re}^{e} smaller than the actual τ chosen by the ruler and decreasing in the religious effort of the clerics: α_c

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$$\tau^e_{Re} = \tau(1 - \theta\alpha_c)$$

$$\tau^e_S = \tau$$

θ represents the capacity of clerics to legitimate

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Religious Proscriptions

Religious services impose a cost on production effort via *proscriptions* on individual behavior for both religious and secular individuals:

$$c(\alpha_c)\Phi(e_i), \text{ with } \Phi(e_i) = \frac{e_i^2}{2} \text{ and } c(\alpha_c) = 1 + \phi\alpha_c, \ i \in \{Re, S\}$$

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This captures one of the model's building blocks: a tradeoff between religious legitimacy and religious proscriptions with respect to the size of the taxable surplus

- Legitimacy increases the incentive to provide effort for the religious
- But comes at the cost of lowered productivity due to proscriptions

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Political Economy Equilibrium

A societal equilibrium of the policy game obtains a Nash Equilibrium of the simultaneous game between the ruler, clerics, and civil society, weighted by their relative political power

- Tantamount to a bargaining game between the politically powerful
- Relative power of the ruler fixed to $\frac{1}{2}$
- Power of clerics: λ
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- Power of civil society: $1 - \lambda$

Religious services m are chosen to maximize:

$$W = \frac{1}{2}U_r(m) + \frac{\lambda}{2}U_c(m, \alpha_c) + \frac{1-\lambda}{2}\left[qU_{Re}(e_{Re}) + (1-q)U_S(e_S)\right]$$

(Necessary) Snippets of the Model

Cultural Dynamics

The cultural profile of values and preferences in society evolves according to socio-economic incentives

Cultural dynamics are modeled as purposeful inter-generational transmission (Bisin and Verdier 2001, 2017)

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The fraction of religious individuals in the population q_{t+1} follows:

$$q_{t+1} - q_t = q_t(1 - q_t)\{d^*_{Re} - d^*_S\}$$

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Institutional Dynamics

Institutions are exogenous from the perspective of all players at any point in time but change over time to reduce externalities associated with the decisions made by policymakers

Institutional change reflects the changing composition of the cultural groups; can be thought of as delegation of power to different groups based on the prevalence of the associated cultural values

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Institutions at $t+1$, λ_{t+1}, are designed to maximize:

$$\max_{\lambda_{t+1}} \frac{1}{2} U_r(m(\lambda_{t+1})) + \frac{\lambda_t}{2} U_c(m(\lambda_{t+1}), \alpha_c(\lambda_{t+1})) + \frac{1-\lambda_t}{2} \left[q_t U_{Re}(e_{Re}(\lambda_{t+1})) + (1-q_t) U_S\left(e_S(\lambda_{t+1})\right) \right]$$

Well ... you gotta see the model (cit.)

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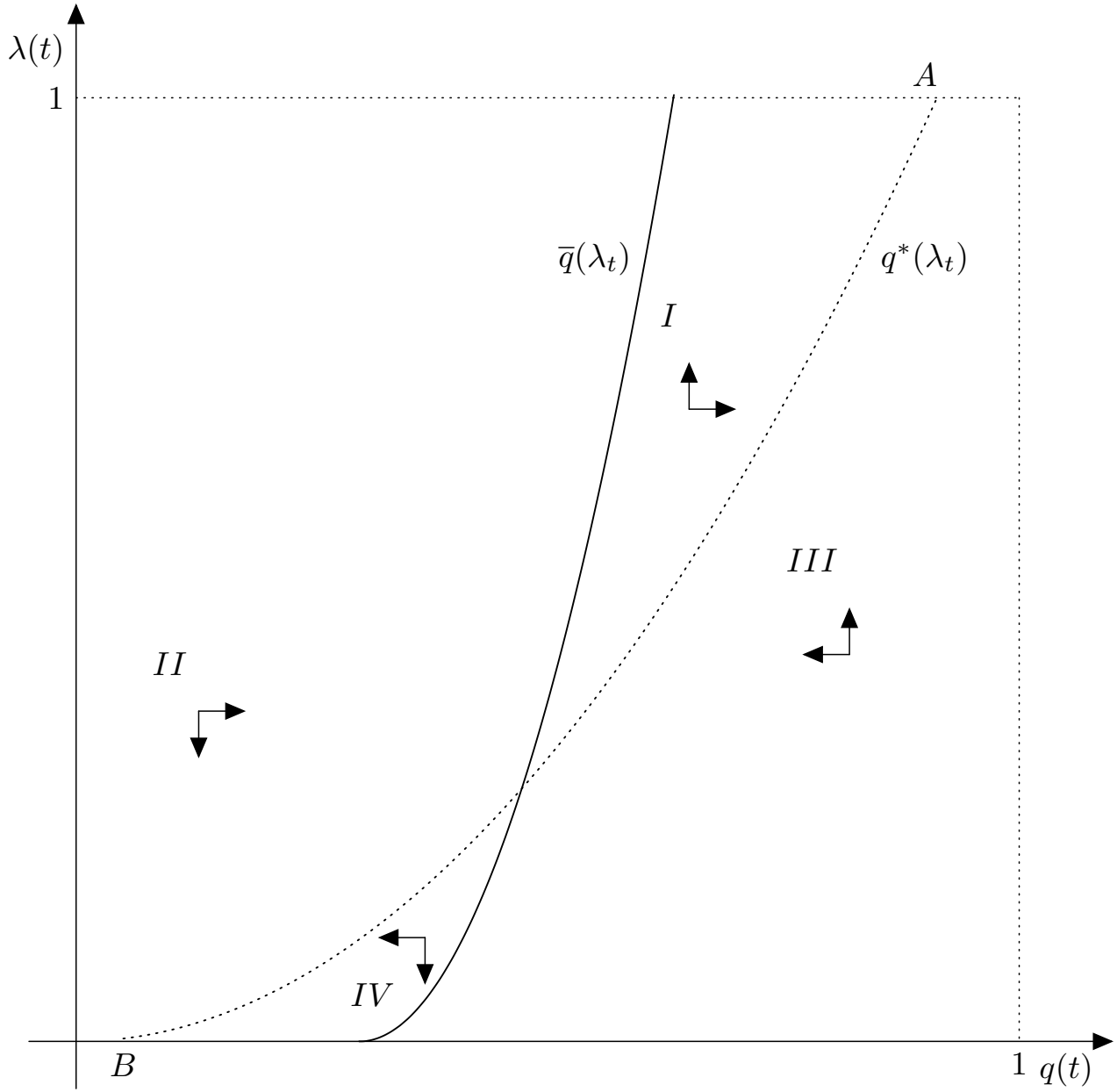
A higher fraction of religious individuals augments the political incentives for the ruler to delegate power to clerics to increase legitimacy

Dynamics of Culture and Institutions

Phase Diagram



Dynamics of Culture and Institutions

Stationary States

Two stationary states emerge from our basic set-up:

1. "Religious" Equilibrium: clerics have substantial political influence, rulers provide clerics with religious infrastructure, clerics legitimate the ruler, and cultural values aligned with clerics' doctrine are predominant in the population
2. "Secular" Equilibrium: clerics do not have much political influence, rulers do not invest in religious infrastructure, clerics do not legitimate the ruler, and cultural values aligned with clerics' doctrine are not predominant in the population

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Key insight: cultural and institutional changes are dynamic complements along the path to convergence to each equilibrium

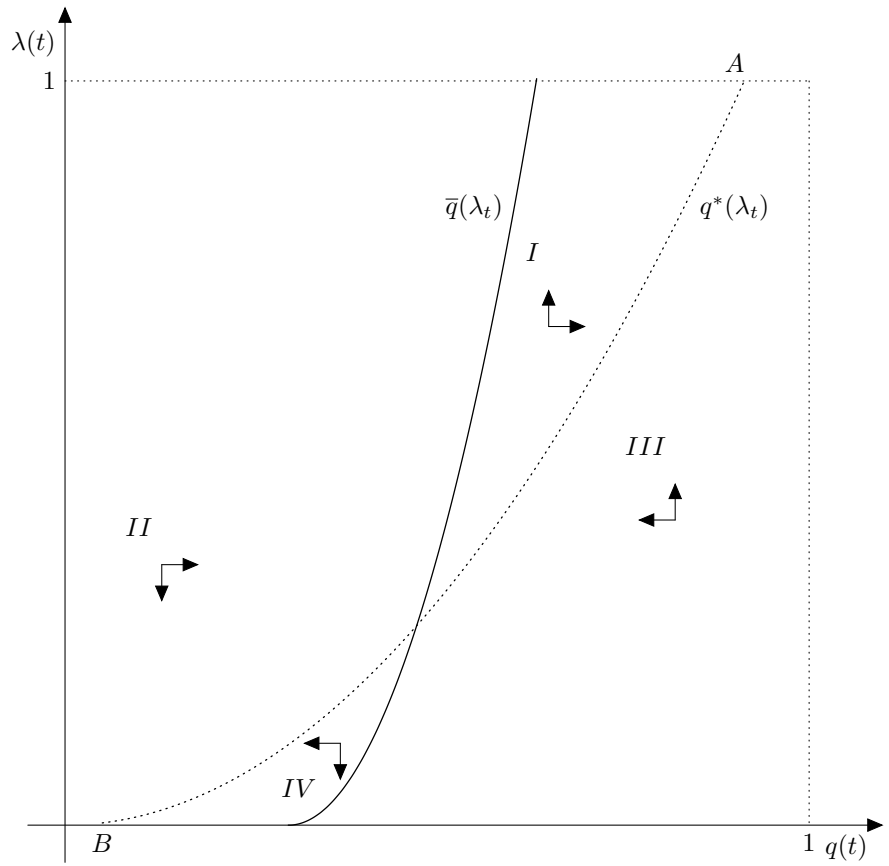
- Complementarity at high λ-high q (and low λ-low q) drives the relative slopes of $\overline{q}(\lambda)$ and $q^*(\lambda)$ and hence the stability of the stationary states

Dynamics of Culture and Institutions

Basins of Attraction/Convergence

Regions I & IV: dynamics of culture and institutions are complementary

- Delegating power to clerics reinforces the incentives of religious individuals to transmit their values inter-generationally
- A predominance of religious individuals augments the incentives of the ruler to commit to empower the clerics

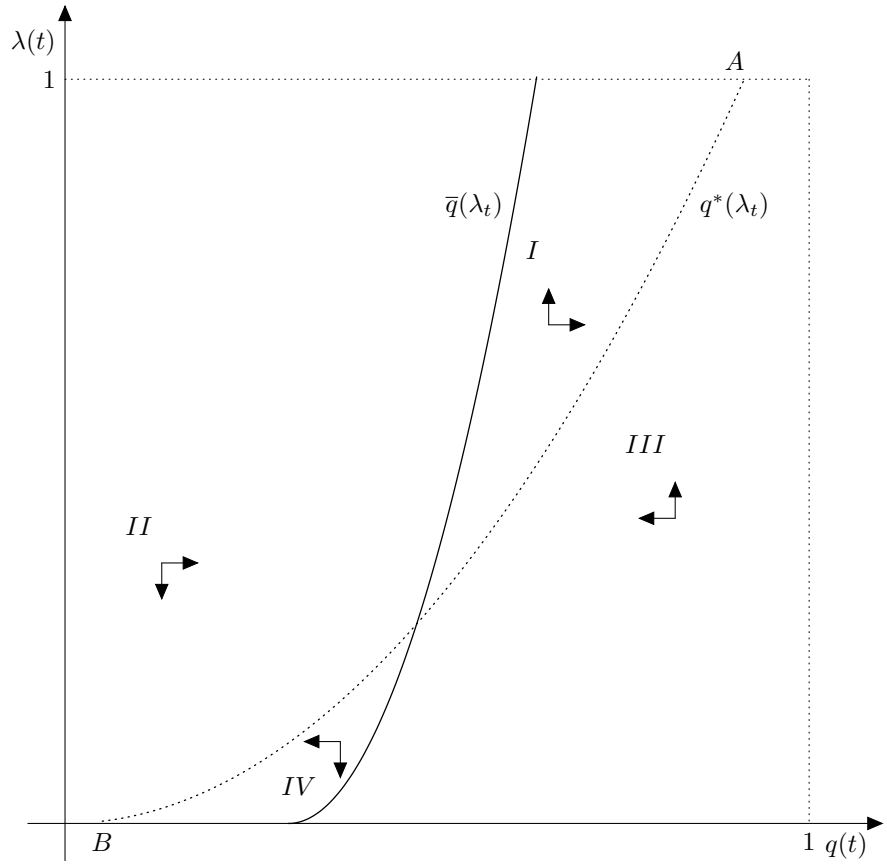


Dynamics of Culture and Institutions

Basins of Attraction/Convergence

Regions II & III: dynamics are transitory

- Region II: religious individuals are few, low incentive to empower clerics, but religious values are transmitted more than secular values
- Depending on the relative speeds of institutional and cultural change, dynamics either reach I or IV: a horse race between institutional and cultural change



Comparative Dynamics

Legitimating Capacity θ

Increase in legitimating capacity θ

Lowers the subjectively perceived tax rate of the religious

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Complementarity between the spread of religious values and institutional change delegating power to clerics is reinforced over time $\Longrightarrow$ larger basin of attraction for the Religious Equilibrium

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Religious Proscriptions ϕ

Increase in religious proscriptions ϕ

Higher cost to ruler of using religious legitimacy

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- Ruler has less incentive to seek legitimacy from clerics

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Complementarity between the spread of religious values and institutional change delegating power to clerics is weakened over time $\Longrightarrow$ larger basin of attraction for the Secular Equilibrium

Mapping the Model to the Historical Narrative

Parameters θ and ϕ

Islam had greater capacity to legitimate political rule than Christianity (θ)

- Christianity: born into (Roman) empire with well-developed legal and political institutions – initial doctrine was built for survival "render unto Caesar ..."
- Islam: developed alongside empire – much doctrine supporting religious legitimation of political rule

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- Islam: developed alongside empire – much doctrine supporting religious legitimation of political rule

Economically-inhibitive religious proscriptions existed in both religions, but were more pervasive and persisted for much longer in Islam (ϕ)

- Consequence of persistent use of religious law in commercial sphere
- Emergence of secular law in Europe undermined proscriptions

Mapping the Model to the Historical Narrative

Initial Conditions q and λ

Christianity was much more widespread among civil society than Islam (in their relative polities) in the early Middle Ages (q)

- Christianity: widespread by the late-5th century when Germanic tribes began to conquer parts of the former Roman Empire
- Islam: small minority of population when the Umayyad Caliphate extended from Spain to South Asia in 7th–8th centuries

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Islam was much more central than Christianity to the power structure (in their relative polities) in the early Middle Ages (λ)

- Christianity: developed under separation of state and church
- Islam: clerics used to provide law, order, tax collection, legitimacy from the first Islamic century

Mapping the Model to the Historical Narrative

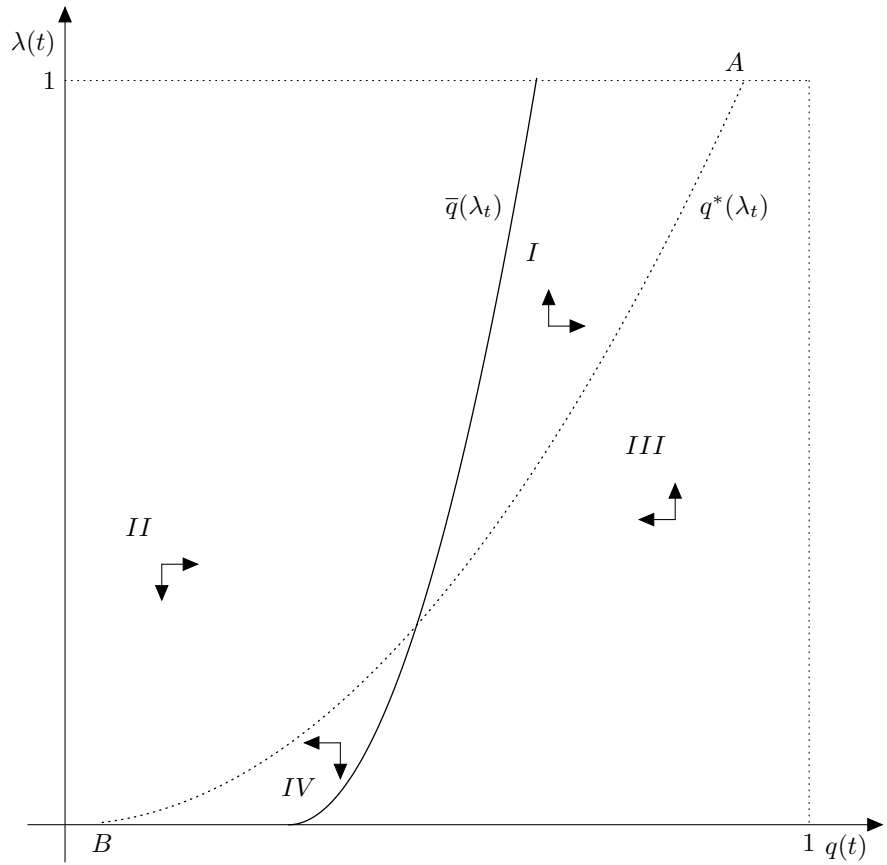
(Brutal) Summary

Middle East and Islam

- high λ_0, low q_0, high θ, high ϕ
- Dynamics from Region II to a "Religious Equilibrium"

Western Europe and Christianity

- low λ_0, high q_0, low θ, low ϕ
- Dynamics from Region III to a "Secular Equilibrium"



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Snippets of History: Dynamics in Western Europe

What wins the "horse race" between cultural and institutional change?

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- ...was not fast enough: the rebirth of commerce in 11th–13th centuries entailed that religious proscriptions were more harmful $\Longrightarrow$ rulers broke with the Church, starting with the Investiture Controversy (1076–1122) through the Reformation

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- Institutional change favoring secular legitimacy: "rationalist" school of Islamic thinking (independent reasoning, development of scientific knowledge) dominated until the 10th century
- ...was not fast enough: in the 11th century the "traditionalist" school won out; "closing of the gate of the Ijtihad"
  - Traditionalist school established madrassas, scientific production began to decline in 11–12th centuries (Chaney 2016)
  - Religious consolidation continued under the Ottoman Empire

Political Decentralization

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- Ruler, religious clerics, and secular elite (e.g., feudal lords, parliament, military); citizens in the background
- Secular elite administers taxation, enforces compliance, and shares tax proceeds with the ruler (in fraction β)
- Three stylized regimes:
  1. $\lambda = 1$: theocracy
  2. $\lambda = 0, \beta = 1$: dictatorship
  3. $\lambda = 0, \beta = 0$: republic

We cannot possibly have time for this extension...?

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Religious regime with political centralization

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Converges towards a religious regime with political centralization: β is high, clerics have significant political power ($\lambda = 1$)

- Fiscal capacity is low, as the secular elite have minimal incentive to enforce tax collection

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Converges towards a secular regime with political decentralization: β is low, clerics have little political power ($\lambda = 0$)

- Fiscal capacity is high given that secular elites have strong incentives to enforce tax collection
- There is a fiscal capacity tradeoff between religious legitimacy and political decentralization

Insights in Context of the Literature

There is a large literature on the role that fiscal capacity and the power of the purse plays in economic outcomes (North and Weingast 1989; Besley and Persson 2009; Dincecco 2009; Johnson and Koyama 2017)

We add additional insight by showing that political decentralization engenders cultural change (i.e., secularization) that reinforces the state's fiscal capacity

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There is a large literature on the role that fiscal capacity and the power of the purse plays in economic outcomes (North and Weingast 1989; Besley and Persson 2009; Dincecco 2009; Johnson and Koyama 2017)

We add additional insight by showing that political decentralization engenders cultural change (i.e., secularization) that reinforces the state's fiscal capacity

Primary insight: rulers will only decentralize political authority when the returns from religious legitimacy are sufficiently low. This in turn triggers cultural change to a more secular society (and vice versa)

Historical Stylized Pattern

Political Centralization and the Long Divergence

Following the fall of the Western Roman Empire, rulers had relatively weak fiscal power relative to other (feudal) elites (low β)

Muslim rulers had the upper hand against other elites (high β), in part due to slave soldiers under their purview (Blaydes and Chaney 2013)

Historical Stylized Pattern

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Muslim rulers failed to decentralize political power not because they feared other elites would become too strong. They did so because political decentralization would weaken the efficacy of religious legitimacy

- More power to secular authorities would have encouraged a cultural shift to a more secular state, yielding religious legitimacy less effective
- Given the relative efficacy of religious legitimacy, this would not have been an optimal strategy for a Muslim ruler

Europe's Political Decentralization

Medieval W. Europe: relatively weak initial power of rulers combined with the relatively weak legitimating capacity of the Church incentivized rulers to decentralize political power

Europe's Political Decentralization

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"Secular equilibrium" emerged: religious proscriptions barely impinged on economic development, fiscal capacity was (eventually) relatively high

Europe's Political Decentralization

Medieval W. Europe: relatively weak initial power of rulers combined with the relatively weak legitimating capacity of the Church incentivized rulers to decentralize political power

"Secular equilibrium" emerged: religious proscriptions barely impinged on economic development, fiscal capacity was (eventually) relatively high

- Feudal institutions gave lords great power over their local domains, and in return the lords provided military service and tax revenue to their sovereign (Duby 1982)
- Ultimately, parliaments became the primary institution which bargained with European rulers (van Zanden et al. 2012)
- As warfare became more expensive, rulers ceded more to the (economic) elites in parliaments $\Longrightarrow$ much greater fiscal capacity

Relative Political Centralization in MENA

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- For instance, around $\frac{3}{4}$ of Ottoman revenues through *tımar* system, a military lease contract whereby the provincial cavalry collected agricultural taxes directly from the peasantry
- *Timar*s rotated, holders never organized like parliaments
- Religious legitimacy remained important $\Longrightarrow$ sultans ceded purview over commercial law to religious authorities $\Longrightarrow$ weak fiscal capacity

Concluding Thoughts

Our main goal: present a unifying theory of the mechanisms underlying the "long divergence," emphasizing the interaction between cultural and institutional evolution

We find that each of the three major theories (based on legitimacy, religious proscriptions, and political decentralization) complement each other when the role of cultural and institutional evolution is considered

We also have an extension on technology adoption (key for understanding the rise of the modern economy!)

THANK YOU!

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The Model

Back

Setup

Three types of agents: a ruler, clerics, and civil society

- Civil society composed of two types i of citizens
  - Religious individuals ($i = Re$) in proportion q
  - Secular individuals ($i = S$) in proportion $1 - q$

The Model Back

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  - $e_i, i \in \{Re, S\}$: per capita work effort

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- Ruler lives off taxing civil society at a tax rate τ
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- Ruler builds and maintains religious infrastructure, m, for clerics to provide religious services
  - Total religious services provided are $\alpha_c m$
  - α_c: effort of the (representative) cleric
  - Cost: $C(m)$ to ruler for building; $F(m)$ to cleric for maintenance

The Model Back

Role of Legitimacy

The provision of religious services facilitates governance and obedience for religious individuals

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The provision of religious services facilitates governance and obedience for religious individuals

We capture this by assuming that religious individuals subjectively perceive a tax rate τ^e_{Re} smaller than the actual τ chosen by the ruler and decreasing in the religious effort of the clerics, α_c

$$\tau^e_{Re} = \tau(1 - \theta\alpha_c)$$

$$\tau^e_S = \tau$$

θ represents the capacity of clerics to legitimate

The Model Back

Role of Religious Proscriptions

Religious services have an indirect cost by imposing *proscriptions* on individual behavior for both religious and secular individuals

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We capture this by assuming the cost of individual production effort is

$$c(\alpha_c)\Phi(e_i), \text{ with } \Phi(e_i) = \frac{e_i^2}{2} \text{ and } c(\alpha_c) = 1 + \phi\alpha_c, \ i \in \{Re, S\}$$

$\phi > 0$ represents the degree of restrictiveness of religious prescriptions on economic activities

The Model

Back

Preferences

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The Model

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Ruler's utility: $U_r(m) = \tau E - C(m)$

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- $\Psi(\alpha_c)$ is cost of providing religious services

Citizens' utility: $U_i(e_i) = e_i(1 - \tau_i^e) - c(\alpha_c)\Phi(e_i), \quad i \in \{Re, S\}$

Note: $C(.)$, $F(.)$, and $\Psi(.)$ are increasing and convex in their argument

Equilibrium

Back

At any time t societal equilibrium is Nash:

Equilibrium

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- Ruler and clerics choose policy m - religious services - to maximize social welfare:

$$W = \frac{1}{2}U_r(m) + \frac{\lambda}{2}U_c(m, \alpha_c) + \frac{1-\lambda}{2}\left[qU_{Re}(e_{Re}) + (1-q)U_S\left(e_S\right)\right]$$

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This policy choice environment is plagued by lack of commitment (eq'm concept is Nash)

Institutional Change

Back

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Institutional change operates as a commitment mechanism which internalizes two externalities that are not taken into account by individual decisions in equilibrium

1. The provision of religious infrastructure m grants legitimacy to the ruler by reducing the subjectively perceived tax rate for religious individuals
2. The provision of religious infrastructure also has a depressing effect on labor productivity via proscriptions

Institutional Change Back

Institutional change - formally

Institutional Change

Back

Institutional change - formally

- Institutions at $t+1$, λ_{t+1}, are designed to maximize:

$$\max_{\lambda_{t+1}} \frac{1}{2} U_r(m(\lambda_{t+1})) + \frac{\lambda_t}{2} U_c(m(\lambda_{t+1}), \alpha_c(\lambda_{t+1})) + \frac{1-\lambda_t}{2} \left[q_t U_{Re}(e_{Re}(\lambda_{t+1})) + (1-q_t) U_S\left(e_S(\lambda_{t+1})\right) \right]$$

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- (roughly) λ_{t+1} is such that $m(\lambda_{t+1})$ is the Stackelberg eq'm choice of the ruler's problem with institutions λ_t

Cultural Dynamics

Back

The parental socialization problem is such that:

- Parents are imperfectly altruistic and have a bias for children sharing their own cultural trait
- Parents of type $i \in \{Re, S\}$ have socialization costs that are increasing and convex in d_i
- Religious infrastructures m_t may act as complementary inputs to the transmission effort d_{Re} of religious families in the socialization of children to the religious trait

Cultural Dynamics

Back

Cultural dynamics - formally

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Cultural dynamics - formally

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- probability P_{ij} that a child in group i is socialized to trait j:

$$P_{ii} = d_i + (1 - d_i)q_i$$
$$P_{ij} = (1 - d_i)q_j$$

  with $q_{Re} = q$ and $q_S = 1 - q$

- The fraction of religious individuals in the population q_{t+1} follows:

$$q_{t+1} - q_t = q_t(1 - q_t)\{d^*_{Re} - d^*_S\}$$

Characterization

Lemmata

Religious infrastructures: The optimal investment in religious infrastructures, $m(\lambda)$, and the optimal effort of the clerics, $\alpha_c(\lambda)$, are increasing in λ and independent from θ and ϕ

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Labor effort: The effort of secular individuals, $e_S(\lambda)$, is decreasing in λ and ϕ and is independent from θ. On the other hand, as long as $\theta \geq \frac{\phi(1-\tau)}{\tau}$, the effort of religious individuals, $e_{Re}(\lambda)$, is increasing in λ and θ, and is decreasing in ϕ

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Tax base: The tax base is increasing in q and θ, and is decreasing in ϕ. It increases with λ as long as $q \geq \frac{\phi(1-\tau)}{\tau\theta}$

Characterization

Uniqueness of Equilibrium

The institutional optimization problem admits a unique solution $\lambda_{t+1} \in [0, 1]$. The solution is characterized by a threshold $\overline{q}(\lambda_t) \in [0, 1]$ such that,

$$\lambda_{t+1} > \lambda_t \text{ (resp. } \leq), \text{ if } q_t > \overline{q}(\lambda_t) \text{(resp. } \leq).$$

Furthermore, the threshold $\overline{q}(\lambda_t)$ is decreasing in θ and increasing in ϕ

Characterization

Cultural Change

Proposition

There exists a threshold $q^*(\lambda_t)$ *such that*

$$q_{t+1} < q_t \, (resp. \geq) \, if \, q_t > q^*(\lambda_t) (resp. \leq).$$

Furthermore, the threshold $q^*(\lambda_t)$ *is increasing in* θ *and* λ_t *and decreasing in* ϕ.

Characterization

Stationary States

Two stationary states

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1. "Religious regime": Point A, ruler is legitimated by religion, clerics have significant political power (λ is high), taxation is high (tax base E is high), and share of religious individuals in civil society is high (q is high)

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1. "Religious regime": Point A, ruler is legitimated by religion, clerics have significant political power (λ is high), taxation is high (tax base E is high), and share of religious individuals in civil society is high (q is high)
2. "Secular regime": Point B, ruler is not legitimated by religion, clerics have little political power (λ is zero), taxation is limited (tax base E is small), and civil society is secular (q is small)

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Stationary States

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1. "Religious regime": Point A, ruler is legitimated by religion, clerics have significant political power (λ is high), taxation is high (tax base E is high), and share of religious individuals in civil society is high (q is high)
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In regions I and IV, the joint dynamics of institutions and culture are complementary

Characterization

Joint Dynamics of Culture and Institutions

The likelihood of reaching the religious equilibrium is increasing in religious legitimacy θ and decreasing in the level of religious proscriptions ϕ

Actions and Utility

Back

Secular elite puts forth effort of tax enforcement α_l, shares cost of religious infrastructures

$$U_l(m, \alpha_l) = (1 - \beta)[\tau E - C(m)] - \mu \frac{\alpha_l^2}{2}$$

Citizens decide whether to evade taxes; evasion cost increasing in α_l

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Actions and utility of ruler and clerics similar as before:

$$U_r(m) = \beta(\tau E - C(m)) - \rho \alpha_l$$

$$U_c(m, \alpha_c) = m\alpha_c - F(m) - \psi(\alpha_c)$$

Political Choices and Institutional Change

Back

Religious infrastructures m are collectively chosen to maximize social welfare:

$$\left(1-\frac{\lambda}{2}\right)\left[U_r(m)+U_l(m,\alpha_l)\right]+\frac{\lambda}{2}U_c(m,\alpha_c))$$

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Future institutions $(\lambda_{t+1},\beta_{t+1})$ are designed as the solution to:

$$\max_{\lambda_{t+1},\beta_{t+1}}\left(1-\frac{\lambda_t}{2}\right)\left[U_r(m(\lambda_{t+1}),\alpha_l(\lambda_{t+1},\beta_{t+1}))+\right.$$
$$\left.U_l(m(\lambda_{t+1}),\alpha_l(\lambda_{t+1},\beta_{t+1}))\right]+$$
$$\frac{\lambda_t}{2}U_c(m(\lambda_{t+1}),\alpha_c(\lambda_{t+1})$$

Characterization of Institutional Paths

Back

Whether the ruler delegates more power to clerics over time depends on the fraction of religious individuals q_t

- If the religious are sufficiently numerous, then more weight to the clerics $\lambda_{t+1} > \lambda_t$ increases their effort $\alpha_c(\lambda_{t+1})$
- This increases the utility of the ruler, who benefits from a larger tax base

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When the religious are sufficiently numerous, the political weight of the secular elite relative to the ruler tends to decrease, $\beta_{t+1} > \beta_t$

- As the ruler becomes more reliant on religious legitimacy to raise revenues, he faces weaker incentives to delegate power to the secular elite and to build fiscal capacity

Dynamic Institutional Paths

Back

Proposition

When $C(m)$ and $F(m)$ are sufficiently convex, the optimization problem admits a unique solution $(\lambda_{t+1}, \beta_{t+1}) \in [0,1]^2$ and:

- *There exists a threshold $\bar{q}_d(\lambda_t) \in [0,1]$ such that if $q_t > \bar{q}_d(\lambda_t)$, then $\lambda_{t+1} > \lambda_t$. Otherwise, $\lambda_{t+1} \leq \lambda_t$. Moreover $\bar{q}_d(\lambda_t)$ is decreasing in λ_t.*
- *There exists a threshold $\tilde{q}_d(\lambda_t, \beta_t) \in [0,1]$ with $\tilde{q}_d(\lambda_t, 1) = 1$ such that if $q_t > \tilde{q}_d(\lambda_t, \beta_t)$, then $\beta_{t+1} > \beta_t$. Otherwise, $\beta_{t+1} \leq \beta_t$. Moreover the threshold $\tilde{q}_d(\lambda_t, \beta_t)$ is decreasing in λ_t and increasing in β_t.*

Cultural Evolution

Back

Proposition

With strong enough cultural substitution between vertical and horizontal cultural transmission, there exists a unique threshold $q_d^*(\lambda_t, \beta_t)$ *such that*

$$q_{t+1} < q_t \, (resp. \geq) \, if \, q_t > q_d^*(\lambda_t, \beta_t) \, (resp. \leq)$$